

## LOCOMOTIVE WRECK REPAIR

This application claims benefit of the April 20, 2000, filing date of United States provisional patent application 60/198,562.

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## FIELD OF THE INVENTION

This invention relates generally to the field of railroad transportation, and more specifically to the repair of a locomotive that has been involved in a collision, and in particular to a method for servicing a locomotive by defining repair kits including all of the parts that would be needed to repair a locomotive involved in each of a plurality of common minor collision accidents.

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## BACKGROUND OF THE INVENTION

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Rail transportation in the United States involves thousands of trains operating over thousands of miles of track on a daily basis. While the rail transportation industry takes great strides to achieve accident free operation, it is inevitable that at least some trains will be involved in an occasional accident. Because they most often operate at the forward end of a train, locomotives are the most likely unit of a train to sustain collision damage.

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It is known to conduct collision repair services for locomotives at regional repair centers. Such repair centers may be operated by a rail company or a service provider. A wrecked locomotive is taken to a repair center where the damage is assessed, repair parts are ordered, and the necessary repairs are made to place the locomotive back into service. Locomotive downtime is very expensive for the owner of the locomotive due to the loss of revenue generation. Accordingly, fast turnaround time at repair shops would be desirable. Unfortunately, fast turnaround time at repair shops is not always achieved.

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One of the principal sources of delay in the repair of a damaged locomotive is the availability of parts to perform the repair. To accomplish a collision repair, the locomotive must first be inspected to determine what parts are damaged. Those parts must then be ordered and collected at the repair location. Locomotives are large, complicated machines that are custom-built to order. Accordingly, no two locomotives are exactly the same. Even two locomotives of the same manufacturer's model number may have some different parts as a result of changes in sub-suppliers, the addition of optional features, refinements in design over time, changes/repairs completed after initial assembly, etc. Thus, the assembly of all of the necessary parts for a collision repair is complicated by the necessity of ordering the right parts for that particular locomotive.

Once all of the parts are identified and ordered, they must be collected at the repair location and stored until used. The lead time for various parts may vary from a day or two to several weeks or months. It is a common problem that some of the parts for a particular repair activity are misplaced or used for some other purpose prior to the particular repair being performed. One can understand that a repair shop may be a rather hectic environment where it is easy to misplace or misuse the hundreds of parts necessary for a collision repair. This is especially problematic when a long lead-time part is found to be missing late in the repair sequence.

#### BRIEF SUMMARY OF THE INVENTION

Thus there is a particular need for a technique for shortening the time necessary to accomplish the repair of a wrecked locomotive. Accordingly, a method of preparing for the repair of a damaged locomotive is described herein, the method including: providing a database containing as-built parts information regarding a plurality of locomotives; defining a plurality of repair kits, each repair kit including those parts of a respective locomotive that would have to be replaced to repair damage to

the respective locomotive caused by any one of a plurality of predefined collision events involving any one of a plurality of regions of the respective locomotive, the repair kits including parts selected from the as-built parts information of the database for the respective locomotive; communicating  
 5 a user's assessment of damage to one of the regions of a selected one of the plurality of locomotives; designating a specific repair kit in response to the assessment of damage; and communicating such designation to the user.

The method of the present invention may further include collecting all of the parts included in the specific repair kit and transporting all of  
 10 the parts included in the specific repair kit to a location where the damage to the selected locomotive will be repaired.

The method may further include transporting all of the parts together in a single shipment so that they are more easily applied to the repair of the locomotive with less risk of loss prior to being used for the  
 15 repair.

A method of preparing for the repair of a damaged locomotive is further described as including: assessing the extent of damage to a locomotive; using a database containing as-built parts information regarding the locomotive to develop a list of parts necessary to repair the  
 20 damage to the locomotive; accumulating the parts identified in the list of parts together to form a repair kit for repairing the damage to the locomotive; and shipping the repair kit as a unit to a location where the locomotive will be repaired.

A system for preparing for the repair of a damaged locomotive is  
 25 described herein as having: a parts database containing information regarding the as-built parts contained in a locomotive; a plurality of repair kits defined in the parts database, each repair kit containing a grouping of all of the parts that would have to be replaced to repair damage to the locomotive caused by a respective plurality of predefined collision events;

and a data port for accessing the database to select a specific repair kit in response to actual damage to the locomotive.

The system of the present invention may further include a repair kit containing all of the parts identified in a repair kit, the repair kit  
 5 collected together in a condition for being transported as a single shipment.

## BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present invention will become  
 10 apparent from the following detailed description of the invention when read with the accompanying drawings in which:

FIG. 1 is a schematic illustration of a system that may be used for the repair of a wrecked locomotive.

FIG. 2 is a top view of a locomotive showing regions of the  
 15 locomotive often damaged in a collision.

FIG. 3 is one format of a repair kit listing for a particular region of a particular locomotive.

## DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a schematic illustration of a system 100 that may be used for the repair of a locomotive 102 that has a damaged section 104 resulting from a collision or other mishap. The locomotive 102 is being transported to the location of a repair center 106 where the repairs will be made. One or more parts suppliers 108 are involved in the assembly of a  
 20 repair kit 110 that is being delivered to the repair center 106 for use in the repair of the locomotive 102. As will be described more fully below, the repair kit 110 is preferably delivered as a single unit , i.e. all parts shipped together in one package or in one shipment or in a series of closely coordinated shipments containing all of the parts, drawings and  
 25 instructions necessary for accomplishing the repair.  
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The system 100 may include a service center 112 wherein the necessary resources reside to populate and to maintain a locomotive information database 114. Locomotive database 114 may include a description of the design of a plurality of locomotives 102, complete down  
 5 to an individual part level. The specific part numbers used to assemble an individual locomotive 102 are recorded, along with associated drawing /revision numbers, specification numbers, sub-part numbers, etc. as may be used by the manufacturers of locomotives to control the assembly of a locomotive 102. The extent of the type of information in the database 114  
 10 and the level of completion of the database for each locomotive may vary depending upon the other needs of a particular application. Importantly the database includes information regarding parts of the locomotive that would have to be replaced to repair damage to the locomotive caused by one or more predefined collision events. The database is preferably  
 15 populated with as-built information regarding the locomotives. The term as-built is used herein to refer to the current existing condition of a locomotive, including the original manufacturing information as modified by any repairs, upgrades, substitutions, additions made to the locomotive during its useful life.

Experience resident in the resources of the service center 112 may be used to identify common or probable accident scenarios that may be encountered during the operation of locomotive 102. For example, Figure 2 illustrates a top view of a locomotive 200 having a front end 202 and a rear end 204. In one embodiment of the present invention, six regions of  
 20 locomotive 200 are identified as being susceptible to collision damage, including the four corners A1, B1, A2 and B2, the front center C1 and the rear center C2. For a collision involving any one of these regions, a list may be assembled including of all of the parts of the locomotive that are expected to be damaged. The extent of damage in each region may depend  
 25 upon the energy involved in the collision, i.e. the speed of the locomotive  
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when it collides with an object. Multiple lists may be assembled for each region of the locomotive to reflect collisions of multiple levels of severity. A typical locomotive may include relatively fragile outlying parts, such as platforms, handrails, steps, skirts, pipes, plates, etc. that would be

5 damaged in even minor collisions due to the very large mass and inertia of a locomotive. Accordingly, this invention may be especially useful when applied to accident scenarios involving relatively light damage, since the scope of damage in such low energy collisions may be more predictable.

Referring again to Figure 1, it may be appreciated that the

10 locomotive database 114 may be accessed by a user at the repair center 106 or at any other location via an information network 116, such as the Internet World Wide Web. The user may be a service provider, an owner or employee of the owner of the locomotive, or any other person involved with the repair of a locomotive. Any other form of communications

15 network may be used, for example wireless networks, telephone networks, PBX, etc. Data portals 118, 120 located at the service center 112 and repair center 106 respectively provide access to locomotive database 114 for respective service center and repair center personnel. Such data portals 118, 120 may be personal computers, portable computers, wireless

20 data devices, or other such device known in the art. In this manner, personnel located at the repair center 106 may evaluate the damage 104 on locomotive 102 and then may access the locomotive database 114 via data portal 120. As-built information regarding the locomotive 102 may be selected by entering the specific road number or other unique identifier

25 associated with the locomotive 102. Data portal 120 may be equipped with a graphical user interface, as is known in the art, for displaying information in text, graphical and pictorial formats. Once the user has entered the identifier for a particular locomotive 102, a pictorial representation of the locomotive, such as the one shown in Figure 2, may

30 be presented to the user on a display unit of the data portal 120. The user

may then select the region or regions of the locomotive that are damaged at any level of detail by using a point-and-click feature or by using any other known manner of data input. If more than one level of severity is defined in the database, the user may select the level of severity that best reflects the actual damage. The selected parts may be placed in a shopping cart to be quoted by the manufacturer in a manner known in the art of e-commerce. Logic resident at any location on the information network 116 in the form of a computer program may be used to access the locomotive database 114 to select a repair kit listing corresponding to the damage information provided by the user. The repair kit would contain all of the parts that would be necessary to repair the damage to the selected region(s) of the locomotive for pre-defined collision events. The system may compile all of the parts costs and associated labor costs to calculate a quotation for repairing the damage. In lieu of using a point-and-click feature, the system may be operated using a decision tree approach for arriving at an appropriate repair kit definition. The system would present a series of questions to the user and would select parts and/or present additional questions depending upon the answer provided by the user. For example, the system 100 may present a form for inputting the road number of the locomotive 102 in question, followed by questions asking if the cab portion is damaged, if the truck portion is damaged, etc. For any portion that is damaged, additional questions may be presented to assess the extent of the damage and/or to suggest additional hidden parts that may be damaged. The resultant output may be the same as for a point-and-click system, and may even include a pictorial representation for the user to confirm those portions of the locomotive that are damaged.

Figure 3 illustrates one format for a repair kit listing 300 as may be made available to a user upon the selection of a specific repair kit 110 for a specific locomotive 102. Because the database 114 is preferably maintained to reflect current as-built information for each locomotive in a

fleet, the date 302 of the preparation of the repair kit listing 300 is important. Upgrades installed on the locomotive, changes in part numbers, obsolete parts, recalls, etc. may affect the composition of a repair kit over time. The unique identifier 304 for the particular locomotive must  
5 be shown, since different locomotives will require different repair kits for any given type of collision damage due to differences in the as-built designs of the various locomotives. The region of the locomotive 306 to be repaired by the repair kit may be included as a text description or as an alphanumeric identifier. A complete listing of all of the parts included in  
10 the repair kit may be sorted by part number 308 or part description 310. The quantity 312, price 314 and delivery availability 316 of the parts may be shown. Delivery information may be obtained by providing an appropriate interface to a parts inventory database 122, such as via a data portal 124 operated by the parts supplier 108 and accessed via the  
15 information network 116 as shown in Figure 1. The report may provide a total price quotation 318 for the repair kit, either as an algebraic sum of the individual part prices 314 or as some other total responsive to such algebraic sum, such as including a discount, delivery charges, expediting charges, etc. A forecast ship date 320 for the repair kit may be provided as  
20 a function of the availability dates 316 for the individual parts.

In order to reduce the amount of time that a locomotive 102 must be out of service to accomplish a repair, it may be possible to use the system 100 of the present invention to identify needed repair parts and to place those parts on order before the damaged locomotive 102 arrives at the  
25 repair center 106. An operator on-board the locomotive 102 may report the location and extent of damage 104 to the repair center promptly after the damage 104 occurs. Such communication may take any form, and in one embodiment may involve the use of a data portal 126 located on-board the locomotive 102 and in communication with the repair center 106 via a  
30 wireless communication link 128 to the data network 116. Audio



information 130 and/or video information 132 may be transmitted to describe the damage. In one embodiment, pictorial information may be obtained by the operator on-board the locomotive 102 in the form of a digital photograph or digital video data stream and then transmitted to the repair center 106 before the locomotive arrives at the repair center 106. Such information may allow a user at the repair center 106 to assess the damage and to select an appropriate specific repair kit 110 from among those repair kits pre-defined for that particular locomotive 102. Such selection may be done by using a computer program especially written to make such choices or to assist a human in making such choices, or it may be done by simply selecting a specific repair kit based upon the area of the locomotive that has sustained the damage. The system 100 may provide the user with cost and delivery estimates 318, 320 for obtaining the repair kit, and may allow the user to place a single order for the repair kit as a unit, thereby eliminating the need for a plurality of orders to a plurality of suppliers for all of the parts necessary to accomplish the repair of damage 104. A labor database 134 may be used to provide further information regarding the availability of skilled labor to accomplish the repair. Depending upon the availability of the necessary labor, the user may request a specific delivery date for the arrival of the repair kit 110 at the repair center 106. Advantageously, the repair kit will arrive in a single shipment on a planned date and will include all of the parts, drawings and procedures necessary to accomplish the repair of the damage 104. In this manner the repair may be accomplished without delay due to missing or misplaced parts or instructions.

Database 114 may further be populated with information regarding design changes, upgrades and optional systems that are not built into a particular locomotive but could be added during a repair activity. For example, if the addition of a new feature to lighting system of a locomotive would require the disassembly and disposal of a front light assembly, it

may be advantageous to incorporate that feature during any repair involving the removal/replacement of the front light assembly.

Accordingly, when a user uses system 100 to select a specific repair kit 110, the system 100 may prompt the user with information concerning optional features that may be included in the repair kit. Price/delivery information may be provided for the as-built replacement repair kit and for the upgrade repair kit. The user may then select the repair kit of choice, and appropriate drawings and installation procedures will be provided along with the corresponding parts.

While the preferred embodiments of the present invention have been shown and described herein, it will be obvious that such embodiments are provided by way of example only. Numerous variations, changes and substitutions will occur to those of skill in the art without departing from the invention herein. Accordingly, it is intended that the invention be limited only by the spirit and scope of the appended claims.